

The following Listing of Claims will replace all prior versions, and listings, of claims in the application.

LISTING OF CLAIMS:

1. (Currently Amended) A method of producing heat-expanded microspheres, which comprises the steps of:

providing a plurality of heat-expandable microspheres, each heat-expandable microsphere comprising a shell of thermoplastic resin, and a blowing agent encapsulated therein having a boiling point not higher than the softening point of the thermoplastic resin, and the plurality of heat-expandable microsphere having an average particle size from 1 to 100 μm ;

feeding a gas fluid containing the plurality of heat-expandable microspheres through a gas-introducing tube having which has a dispersion nozzle on an outlet thereof, the dispersion nozzle being [[and]] fixed inside a conduit with a hot gas flow flowing through the conduit, and then jetting the gas flow from the dispersion nozzle;

colliding the gas fluid with a collision plate fixed on a downstream portion of the dispersion nozzle in order to disperse the plurality of heat-expandable microspheres in the hot gas flow; and

heating the plurality of dispersed heat-expandable microspheres in the hot gas flow at a temperature not lower than the expansion initiating temperature of the plurality of heat-expandable microspheres and thus expanding the same.

2. (Currently Amended) A method of producing heat-expanded microspheres according to Claim 1, wherein the gas-introducing tube and/or collision plate is provided with ~~comprised of~~ an overheating prevention function.

3. (Previously Presented) A method of producing heat-expanded microspheres, comprising the steps of:

providing a plurality of heat-expandable microspheres, each heat-expandable microsphere comprising a shell of thermoplastic resin, and a blowing agent encapsulated therein having a boiling point not higher than the softening point of the thermoplastic resin,

the plurality of heat-expandable microspheres having an average particle size from 1 to 100 μm ;

jetting a gas fluid containing the plurality of heat-expandable microspheres through at least one dispersion nozzle fixed outside a hot gas flow, and dispersing the gas fluid in the hot gas flow; and

heating the plurality of dispersed heat-expandable microspheres in the hot gas flow at a temperature not lower than the expansion initiating temperature of the plurality of heat-expandable microspheres to thereby expand the same.

4. (Previously Presented) A method of producing heat-expanded microspheres according to Claim 1, wherein each of the plurality of heat expandable microspheres further comprises a particulate filler that adheres to the outer surface of the shell thereof, the particulate filler having an average particle size not greater than one tenth of the average particle size of the plurality of heat-expandable microspheres without the particulate filler adhered to the surface thereof.

5. (Previously Presented) A method of producing heat-expanded microspheres according to Claim 1, which further comprises the step of wetting the resultant plurality of heat-expanded microspheres with a liquid organic compound which does not dissolve the shells thereof.

6. (Previously Presented) A method of producing heat-expanded microspheres according to Claim 1, wherein the expansion conditions of the plurality of heat-expandable microspheres are controlled in such a manner that the plurality of heat-expanded microspheres do not have a re-expansion initiating temperature.

7. (Previously Presented) A method of producing heat-expanded microspheres according to Claim 1, wherein the expansion conditions of the plurality of heat-expandable microspheres are controlled in such a manner that the plurality of heat-expanded microspheres have a re-expansion initiating temperature.

8. (Previously Presented) A method of producing heat-expanded microspheres according to Claim 1, wherein the blowing agent contains a C₂₋₁₀ lo fluorine compound having an ether structure, and which contains no chlorine and bromine atoms.

9. (Original) A method of producing heat-expanded microspheres according to Claim 8, wherein the thermoplastic resin is produced by polymerizing a monomer mixture consisting essentially of a nitrile monomer and a monomer having a carboxyl group, the weight ratio of the nitrile monomer ranging from 20 to 80 weight percent of the monomer mixture, and the weight ratio of the monomer having a carboxyl group ranging from 80 to 20 weight percent.

10. (Previously Presented) A method of producing heat-expanded microspheres according to Claim 8, wherein each of the plurality of heat-expandable microspheres further comprise a particulate filler that adheres to the outer surface of the shells thereof, the particulate filler having an average particle size not greater than one tenth of the average particle size of the plurality of heat-expandable microspheres without the particulate filler adhered to the surface thereof, and is at least one anti-blocking agent selected from the group consisting of organic compounds having a melting point not lower than 90°C and inorganic compounds having a layered structure.

11. (Original) Heat-expanded microspheres produced by a method in which heat expandable microspheres having an average particle size ranging from 1 to 100 μm , and which each comprise a shell of thermoplastic resin, and a blowing agent having a boiling point not higher than the softening point of the thermoplastic resin and encapsulated in the shell, are heated to a temperature not lower than an expansion initiating temperature of the heat-expandable microspheres to thereby expand the heat-expandable microspheres, wherein the heat-expanded microspheres contain not more than 5 weight percent of aggregated microspheres and not more than 5 weight percent of microspheres having a true specific gravity not lower than 0.79 g/cc at 25°C.

12. (Previously Presented) Heat-expanded microspheres according to Claim 11, wherein the heat-expandable microspheres further comprise a particulate filler that adheres to the outer surface of the shells thereof, the particulate filler having an average particle size not greater than one tenth of the average particle size of the heat-expandable microspheres without the particulate filler adhered to the surface thereof.

13. (Previously Presented) Heat-expanded microspheres according to Claim 11, which are produced by heating and expanding the heat-expandable microspheres, wherein the difference in the coefficient of variation of the particle size distribution between the heat-expanded microspheres and the heat-expandable microspheres is within +/- 5 %.

14. (Previously Presented) Heat-expanded microspheres according to Claim 11, the heat-expanded microspheres having a re-expansion initiating temperature.

15. (Previously Presented) Heat-expanded microspheres according to Claim 11, wherein the heat-expanded microspheres are wetted with a liquid organic compound that does not dissolve the shells thereof.

16. (Previously Presented) Heat-expanded microspheres according to Claim 11, wherein the blowing agent contains a C₂₋₁₀ fluorine compound having an ether structure, and which contains no chlorine and bromine atoms.

17. (Original) Heat-expanded microspheres according to Claim 16, wherein the thermoplastic resin is produced by polymerizing a monomer mixture consisting essentially of a nitrile monomer and a monomer having a carboxyl group, the weight ratio of the nitrile monomer ranging from 20 to 80 weight percent of the monomer mixture, and the weight ratio of the monomer having a carboxyl group ranging from 80 to 20 weight percent of the monomer mixture.

18. (Previously Presented) Heat-expanded microspheres according to Claim 16, wherein the heat-expandable microspheres further comprise a particulate filler that

adheres to the outer surface of the shells thereof, the particulate filler having an average particle size not greater than one tenth of the average particle size of the heat-expandable microspheres without the particulate filler adhered to the surface thereof, and is at least one anti-blocking agent selected from the group consisting of organic compounds having a melting point not lower than 90°C and inorganic compounds having a layered structure.

19. (Previously Presented) Heat-expanded microspheres according to Claim 16, the heat-expandable microspheres exhibiting a damage sealing function and a tire internal pressure supply function after a tire is damaged by filling the heat-expanded microspheres in a cavity of a tire-and-rim assembly.

20. (Currently Amended) Heat-expanded microspheres according to Claim 11, which are produced by the process according to Claim 1 a method that comprises the steps of:

providing a plurality of heat-expandable microspheres, each heat-expandable microsphere comprising a shell of thermoplastic resin, and a blowing agent encapsulated therein having a boiling point not higher than the softening point of the thermoplastic resin, and the plurality of heat-expandable microsphere having an average particle size from 1 to 100 μm ;

feeding a gas fluid containing the plurality of heat-expandable microspheres through a gas-introducing tube which has a dispersion nozzle on an outlet thereof, the dispersion nozzle being fixed inside a conduit with a hot gas flow flowing through the conduit, and then jetting the gas flow from the dispersion nozzle;

colliding the gas fluid with a collision plate fixed on a downstream portion of the dispersion nozzle in order to disperse the plurality of heat-expandable microspheres in the hot gas flow; and

heating the plurality of dispersed heat-expandable microspheres in the hot gas flow at a temperature not lower than the expansion initiating temperature of the plurality of heat-expandable microspheres and thus expanding the same.

21. (Previously Presented) Heat-expandable microspheres, each heat-expandable microsphere comprising:

a shell of thermoplastic resin, and a blowing agent having a boiling point not higher than the softening point of the thermoplastic resin and encapsulated in the shell;

wherein the heat-expandable microspheres have an average particle size ranging from 1 to 1000 μm ;

an expansion coefficient over 100 % at their maximum expanding temperature;

contain not more than 5 weight percent of aggregated microspheres; and

contain not more than 5 weight percent of microspheres having a true specific gravity not lower than 0.79 g/cc at 25°C.

22. (Original) Heat-expandable microspheres according to Claim 21, which further comprise a particulate filler that adheres to the outer surface of the shells thereof and has an average particle size not greater than 10 μm .

23. (Previously Presented) Heat-expandable microspheres according to Claim 21, which contain not more than 1 weight percent of aggregated microspheres and not more than 3 weight percent of microspheres having a true specific gravity not lower than 0.79 g/cc at 25°C.

24. (Previously Presented) Heat-expandable microspheres according to Claim 21, wherein the heat-expanded microspheres which are wetted with a liquid organic compound that does not dissolve the shells thereof.

25. (Previously Presented) Heat-expandable microspheres according to Claim 21, wherein the blowing agent contains a C_{2-10} fluorine compound having an ether structure, and which contains no chlorine and bromine atoms.

26. (Original) Heat-expandable microspheres according to Claim 25, wherein the coefficient of variation of the particle size distribution thereof is not greater than 30 %.

27. (Previously Presented) Heat-expandable microspheres according to Claim 25, wherein the thermoplastic resin is produced by polymerizing a monomer mixture consisting essentially of a nitrile monomer and a monomer having a carboxyl group, the weight ratio of the nitrile monomer ranging from 20 to 80 weight percent of the monomer mixture, and the weight ratio of the monomer having a carboxyl group ranging from 80 to 20 weight percent of the monomer mixture.

28. (Previously Presented) Heat-expandable microspheres according to Claim 25, further comprising a particulate filler that adheres to the outer surface of the shell, the particulate filler having an average particle size not greater than 10 μm , and is at least one selected from the group consisting of organic compounds having a melting point not lower than 90°C and inorganic compounds having a layered structure.

29. (Previously Presented) Heat-expandable microspheres according to Claim 25, the heat-expandable microspheres exhibiting a damage sealing function and a tire internal pressure supply function after a tire is damaged by filling the heat-expanded microspheres in a cavity of a tire-and-rim assembly.

30. (Currently Amended) A porous material composition, which comprises a base component, and heat-expanded microspheres according to Claim 11 and/or heat-expandable microspheres according to Claim 21.

31. (Original) A porous molded product produced by molding a porous material composition according to Claim 30.

32. (Currently Amended) Heat-expandable microspheres, each heat-expandable microsphere comprising:

a shell of thermoplastic resin, and a blowing agent having a boiling point not higher than the softening point of the thermoplastic resin, the heat-expandable microspheres having an average particle size ranging from 1 to 100 μm ;

wherein the blowing agent contains a C₂₋₁₀ fluorine compound having an ether structure, and which contains no chlorine and bromine atoms; and

wherein the thermoplastic resin is produced by polymerizing a monomer mixture consisting essentially of a nitrile monomer and a monomer having a carboxyl group, the weight ratio of the nitrile monomer ranges from 20 to 80 weight percent of the monomer mixture, and the weight ratio of the monomer having a carboxyl group ranges from 80 to 20 weight percent of the monomer mixture; and

each of the heat-expandable microspheres further comprises an anti-blocking agent that adheres to the outer surface of the shell, wherein the anti-blocking agent is at least one selected from the group consisting of: organic compounds having a melting point not lower than 90°C; and inorganic compounds having a layered structure and being selected from the group consisting of mica, bentonite, sericite, molybdenum disulfide, tungsten disulfide, carbon fluoride, calcium fluoride, boron nitride, isinglass, calcium hydroxide, calcium phosphate, magnesium hydroxide and magnesium phosphate.

33. (Cancelled)

34. (Cancelled)

35. (Currently Amended) A method of producing heat-expandable microspheres, each heat-expandable microsphere comprising a shell of thermoplastic resin, and a blowing agent encapsulated therein having a boiling point not higher than the softening point of the thermoplastic resin;

the method of production comprising the step of mixing a monomer mixture and the blowing agent, and then carrying out a suspension polymerization of the resultant mixture in an aqueous suspension;

wherein the monomer mixture consists essentially of a nitrile monomer and a monomer having a carboxyl group, the weight ratio of the nitrile monomer ranging from 20 to 80 weight percent of the monomer mixture, and the weight ratio of the monomer having a carboxyl group ranging from 80 to 20 weight percent; and

wherein the blowing agent contains a C₂₋₁₀ fluorine compound having an ether structure, and which contains no chlorine and bromine atoms; and

the method of production further comprising the step of attaching an anti-blocking agent to the outer surface of the shell, wherein the anti-blocking agent is at least one selected from the group consisting of: organic compounds having a melting point not lower than 90°C; and inorganic compounds having a layered structure and being selected from the group consisting of mica, bentonite, sericite, molybdenum disulfide, tungsten disulfide, carbon fluoride, calcium fluoride, boron nitride, isinglass, calcium hydroxide, calcium phosphate, magnesium hydroxide and magnesium phosphate.

36. (Cancelled)

37. (Currently Amended) A method of producing heat-expandable microspheres, each heat-expandable microsphere comprising a shell of thermoplastic resin, a blowing agent encapsulated therein having a boiling point of not higher than the softening point of the thermoplastic resin, and an anti-blocking agent attached to the outer surface of the shell;

the method of production comprising the steps of:

mixing a monomer mixture and the blowing agent and then carrying out a suspension polymerization of the resultant mixture in an aqueous suspension; and

attaching an anti-blocking agent to the outer surface of the shell, wherein the anti-blocking agent is at least one member selected from the group consisting of: organic compounds having a melting point of not lower than 90°C and inorganic compounds having a layered structure and being selected from the group consisting of mica, bentonite, sericite, molybdenum disulfide, tungsten disulfide, carbon fluoride, calcium fluoride, boron nitride, isinglass, calcium hydroxide, calcium phosphate, magnesium hydroxide and magnesium phosphate; and

wherein the blowing agent contains a C₂₋₁₀ fluorine compound having an ether structure, and which contains no chlorine and bromine atoms.

38. (New) A porous material composition, which comprises a base component, and heat-expanded microspheres according to Claim 21.

Appl. No. 10/595,910
Amendment dated September 17, 2009
Reply to Office Action of June 23, 2009

39. (New) A porous molded product produced by molding a porous material composition according to Claim 39.